• Selectivity.

Protection is arranged in zones, which should cover the power system completely, leaving no part unprotected. When a fault occurs the protection is required to select and trip only the nearest circuit breakers. This property of selective tripping is also called 'discrimination' and is achieved by two general methods:

1. Time graded systems.

Protective systems in successive zones are arranged to operate in times which are graded through the sequence of equipments so that upon the occurrence of a fault, although a number of protective equipments respond, only those relevant to the faulty zone complete the tripping function. The others make incomplete operations and then reset.

2. Unit systems.

It is possible to design protective systems which respond only to fault conditions lying within a clearly defined zone. This 'unit protection' or 'restricted Protection' can be applied throughout a power system and, since it does not involve time grading, can be relatively fast in operation.

Unit protection is usually achieved by means of a comparison of quantities at the boundaries of the zone. Certain protective systems derive their 'restricted' property from the configuration of the power system and may also be classed as unit protection.

Whichever method is used, it must be kept in mind that selectivity is not merely a matter of relay design.

It is a function of the correct co-ordination of current transformers and relays with a suitable choice of relay settings, taking into account the possible range of such variables as fault currents, maximum load current, system impedances and so on, where appropriate.

• Zones of protection

Ideally, the zones of protection should overlap across the circuit breaker as shown in Figure 2, the circuit breaker being included in both zones.

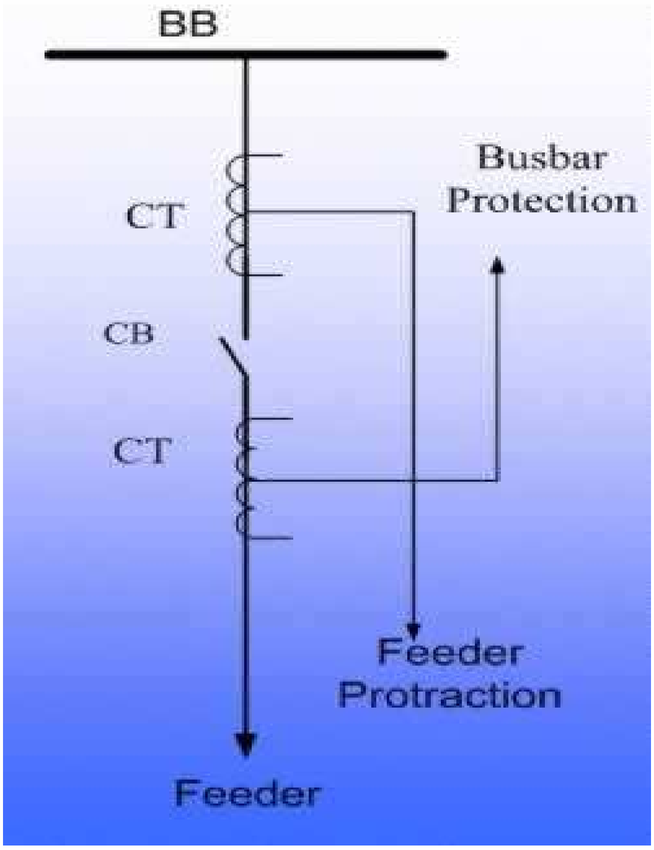


Figure 2. Location of current transformers on both sides of the circuit breaker.

For practical physical reasons, this ideal is not always achieved, accommodation for current trans-formers being in some cases available only on one side of the circuit breakers, as in Figure 3. This leaves a section between the current transformers and the circuit breaker A within which a fault is not cleared by the operation of the protection that responds. In Figure 3 a fault at F would cause the bus-bar protection to operate and open the circuit breaker but the fault would continue to be fed through the feeder.

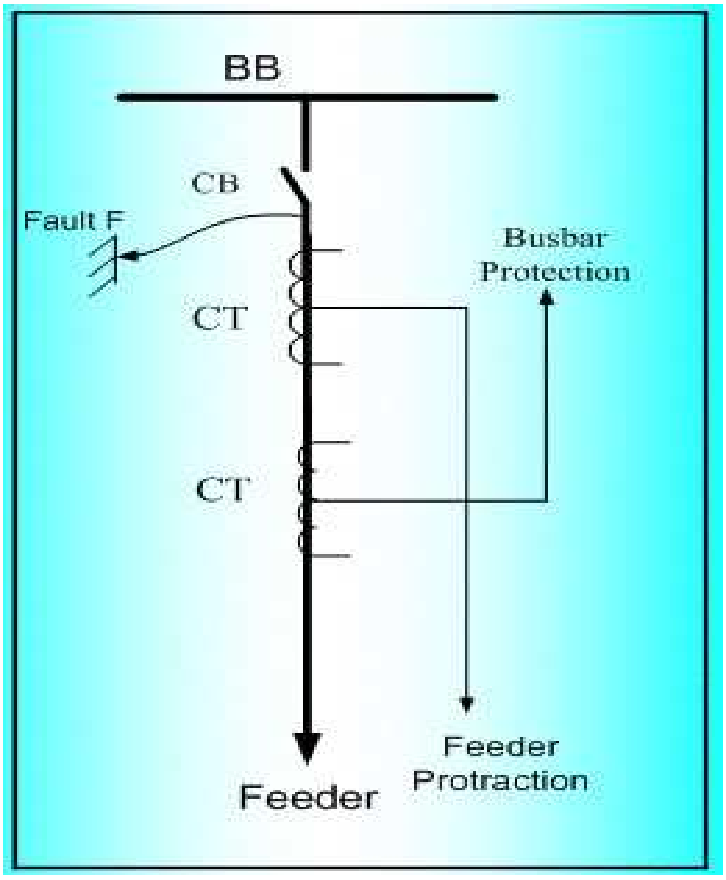


Figure 3 Location of current transformers on circuit side of the circuit breaker.

The feeder protection, if of the unit type, would not operate, since the fault is outside its zone. This problem is dealt. With by some form of zone extension, to operate when opening the circuit breaker does not fully interrupt the flow of fault current. A time delay is incurred in fault clearance, although by restricting this operation to occasions when the bus-bar protection is operated the time delay can be reduced.

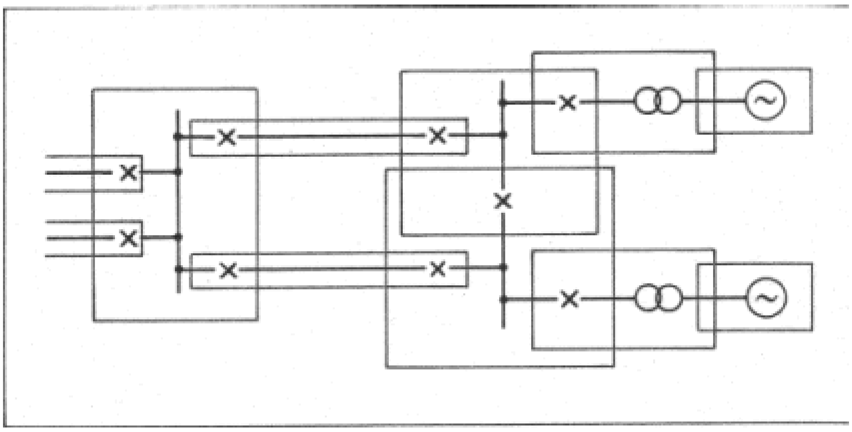


Figure 4 Overlapping zones of protection systems.

The point of connection of the protection with the power system usually defines the zone and corresponds to the location of the current transformers. The protection may be of the unit type, in which case the boundary will be a clearly defined and closed loop. Figure 4 illustrates a typical arrangement of overlapping zones.

Alternatively, the zone may be unrestricted; the start will be defined but the extent will depend on measurement of the system quantities and will therefore be subject to variation, owing to changes in system conditions and measurement errors.